METHOD AND SYSTEM FOR MEASURING AN OBJECT IN DIGITAL IMAGE

BY

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BACKGROUND OF THE INVENTION

The present invention relates to method and system of measuring an object in a digital image. More particularly, this invention relates to method and system of measuring an object in a digital image when the image is bigger than a viewing window of an optical instrument such as a microscope.

There have been many image analysis programs or image measurement programs that measure objects in a digital image obtained by a microscope or a digital camera with the pixel values displayed in a computer monitor window that is connected to the microscope or digital camera. If an object is big and thus cannot be displayed as a whole in the monitor window, direct measurement from the image displayed in the monitor at a given moment is not possible.

In order to measure such oversize objects, a measuring microscope with a measuring stage and a profile projector have been used. FIG. 1 shows an example of a microscope **10** by prior art. A measuring stage **12** moves an object in X/Y/Z

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axes, and provides the X/Y/Z coordinates of an object before and after the movement. A measuring program by prior art used the data provided by a measuring stage to measure the size of an object in a digital image. A measuring stage needs to provide precise movement of an object to be measured and accurately measure movement in the XY plane or the XYZ space. This requires expensive mechanical parts, interfaces and other accommodations between the measuring stage and the measuring program.

SUMMARY OF THE INVENTION

The present invention contrives to solve the disadvantages of the prior art.

An objective of the invention is to provide a measuring method and system for measuring oversize objects in a digital image without a measuring stage.

Another objective of the invention is to provide a digital image measuring method and system that has a manual, semi-automatic and automatic modes to maximize efficiency and versatility of the system.

Still another objective of the invention is to provide a digital image measuring method and system that can recognize and determine the moving distance and geometrical data of multiple objects in a digital image.

To achieve the above objectives, the present invention provides a method of measuring an object in a two-dimensional digital image. The object is moved to cover a portion of the object that is not viewed in a viewing window. A first image of the object, which is captured before the object is moved, and a second image of the object, which is captured after the object is moved, are used in measuring. The method includes the steps of detecting two-dimensional displacement of the image by comparing the position of one reference point of the object in the first image and the position of the same reference point of the object in the second image, and calculating geometrical data of the object.

The step of detecting two-dimensional displacement includes moving the second image so that the second image overlaps the first image.

In the step of moving the second image, overlapping is determined by minimizing sum of the luminosity value of a specific point or area of the first image and the luminosity value of the same point or area of the second image. The luminosity of a part of the second image, which includes the point or area, is set to be the negative value of the luminosity of the originally captured second image.

The step of detecting two-dimensional displacement may be repeated one or more times in order to cover a large object.

In the step of detecting two-dimensional displacement, the coordinates of one or more points of the object in the first image are memorized. When the object is moved, the displacement of the object is automatically calculated. The automatic calculation may be performed within a partial range of the first image determined by a user. This is advantageous when there are many objects of the same pattern. The overlapping may be performed manually also.

In case that the geometrical data is one-dimensional, the two-dimensional coordinates of a measuring point of the first image relative to the reference point, and the two-dimensional coordinates of a measuring point of the second image relative to the reference point are used in the step of calculating the geometrical data of the object.

In case that the geometrical data is two-dimensional, the two-dimensional coordinates of one or more measuring points of the first image relative to the reference point, and the two-dimensional coordinates of one or more measuring points of the second image relative to the reference point are used in the step of calculating the geometrical data of the object.

The invention also provides a system of measuring an object in a two-dimensional digital image. The system includes a detection module detecting two-dimensional displacement of the image by comparing the position of one reference point of the object in the first image and the position of the same reference point of the object in the second image, and a calculation module calculating geometrical data of the object.

The detection module moves the second image so that the second image overlaps the first image. In the detection module, overlapping is determined by minimizing sum of the luminosity value of a specific point or area of the first image and the luminosity value of the same point or area of the second image. The luminosity of a part of the second image, which includes the point or area, is set to be the negative value of the luminosity of the originally captured second image.

The detection module repeats detecting two-dimensional displacement one or more times as needed.

The detection module memorizes the coordinates of one or more points of the object in the first image. When the object is moved, the detection module automatically calculates the displacement of the object. This calculation

may be performed within a partial range of the first image determined by a user.

The calculation module uses the two-dimensional coordinates of one or more measuring points of the first image relative to the reference point, and the two-dimensional coordinates of one or more measuring points of the second image relative to the reference point in calculating the one-dimensional or two-dimensional geometrical data of the object.

The advantages of the present invention are: (1) a digital microscope that does not need a measuring stage and measures objects only from the data included in digital images themselves is provided; and (2) a digital image measuring software that has various user-friendly features and powerful calculation options is provided.

Although the present invention is briefly summarized, the fuller understanding of the invention can be obtained by the following drawings, detailed description and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present invention will become better understood with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic elevation view showing a microscope by prior art;

FIG. 2 is a flow diagram showing a digital image measuring method according to the present invention;

FIG. 3 is a block diagram showing a digital image measuring system according to the present invention;

FIG. 4 is a screen capture showing a preview window;

FIG. 5 is a screen capture showing a reference point on a object in a first image;

FIG. 6 is a screen capture showing a second image of the moved object;

FIG. 7 is a screen capture showing the first image and the second image simultaneously;

FIG. 8 is a screen capture showing the second image is overlapped with the first image;

FIG. 9 is a screen capture showing coordinates of the reference point is compensated;

FIG. 10 is a screen capture showing coordinates of a point on the object is compensated; and

FIG. 11 is a screen capture showing a menu for automatic calculation parameters.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 2 shows a flow diagram for a digital image measuring method according to the present invention. The object is moved to cover a portion of the object that is not viewed in a viewing window **14** (refer to FIG. 4). A first image **16** of the object (refer to FIG. 5), which is captured before the object is moved, and a second image **18** of the object (refer to FIG. 6), which is captured after the object is moved are used in measuring. The method includes step **S01** of detecting two-dimensional displacement of the image by comparing the position of one reference point of the object in the first image and the position of the same reference point of the object in the second image, and step **S02** of calculating geometrical data of the object.

FIG. 3 shows a digital image measuring system **20** according to the present invention. The system **20** includes a detection module **22** that detects two-dimensional displacement of the image by comparing the position of one reference point **24** (refer to FIG. 5) of the object in the first image **16** and the position of the same reference point **24** of the object in the second image **18**, and a calculation module **26** that calculates geometrical data of the object.

FIGS. 4-10 are screen captures that illustrate operations of the system **20**. FIG. 4 shows the viewing window **14** of a digital optical instrument, for example, a microscope. FIG.

5 shows a reference point **24** on an object **28** in the first image **16**.

The object **28** is moved in order to cover portions of the object **28** that are not seen in the viewing window **14**. This movement is done by a stage attached to a microscope. In this case the stage has only the role of moving the object **28** and does not provide displacement data like a measuring stage. The first image **16** is captured before the object **28** is moved, and the second image **18** is captured after the object **28** is moved. FIG. 6 shows the second image **18** of the moved object **28** with a reference point **24'** that corresponds the reference point **24** of the first image **16**. FIG. 7 shows the first image **16** and the second image **18** simultaneously.

Step **S01** of detecting two-dimensional displacement **S01** includes a step **S03** of moving the second image **18** or the first image **16** so that the second image **18** overlaps the first image **16**. This movement of the second image **18** is performed by the detection module **22** of the digital image measuring system **20**.

FIG. 8 shows that the second image **18** is overlapped with the first image **16** with the reference point **24, 24'** coincided with each other.

In step **S03** of moving the second image, overlapping is determined by minimizing sum of the luminosity value of the

reference point **24** or an area of the first image **16** and the luminosity value of the reference point **24'** or an area of the second image **18**. The luminosity of a part of the second image **18**, which includes the reference point **24'** or area, is set to be the negative value of the luminosity of the originally captured second image **18**.

Step **S01** of detecting two-dimensional displacement may be repeated one or more times by the detection module **22** in order to cover a large object.

In a first embodiment, in step **S01** of detecting two-dimensional displacement, the coordinates of one or more points of the object **28** in the first image **16** are memorized by the detection module **22**. When the object **28** is moved, the displacement of the object **28** is automatically calculated by the detection module **22**.

In a second embodiment, the automatic calculation may be performed within a partial range of the first image **16** determined by a user. The first image **16** or the second image **18** is moved to the other image manually. Then automatic detection is perform with the partial range. This is advantageous when there are many objects of the same pattern. In a third embodiment, the overlapping is performed by manually moving the object **28**. An indicator shows the sum of luminosity values that is explained above.

When the value shown by the indicator is minimized, the first image **16** and the second image **18** are overlapped.

In case that the geometrical data is one-dimensional, such as length or width of the object **28**, the two-dimensional coordinates of a measuring point of the first image **16** relative to the reference point **24**, and the two-dimensional coordinates of a measuring point of the second image **18** relative to the reference point **24'** are used in step **S02** of calculating the geometrical data of the object **28** by the calculation **26** of the digital image measuring system **20**.

In case that the geometrical data is two-dimensional, such as the area of the object **28**, the two-dimensional coordinates of one or more measuring points of the first image **16** relative to the reference point **24**, and the two-dimensional coordinates of one or more measuring points of the second image **18** relative to the reference point **24'** are used in step **S02** of calculating the geometrical data of the object **28**.

The geometrical data provided by the digital image measuring system **20** includes the length, area, radius, diameter, angle and distance, etc. of the object **28**.

FIG. 9 shows that coordinates of the reference point **24**, **24'** is compensated or calculated according to the result of

step **S01**. Arrow 1 means X, Y coordinate pixel values of the moved window. Arrow 2 shows that X, Y coordinates of the reference points are compensated with the value indicated by arrow 1.

FIG. 10 shows that the coordinates of a point **30** on the object **28** is compensated or calculated in a way similar to that in FIG. 9.

FIG. 11 shows a menu for automatic calculation parameters that are used in the method of the present invention. Max movement scan indicates the range in which the digital image measuring system **20** detects displacements automatically. Primary direction means X-axis, and secondary direction means Y-axis. FIG. 11 shows the range as 500 pixels in primary direction and 70 pixels in the secondary direction. The numbers can be adjusted by the user.

While the invention has been shown and described with reference to different embodiments thereof, it will be appreciated by those skilled in the art that variations in form, detail, compositions and operation may be made without departing from the spirit and scope of the invention as defined by the accompanying claims.